Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 32 (2012) 502 – 508

Procedia Engineering

www.elsevier.com/locate/procedia

I-SEEC2011

A New THz Frequency Band Generation for Optical radio System of RFID Applications

B. Sansoda[a*], S. Thongmee[b] , N. Pornsuwancharoen[c], P.P. Yupapin[d], R. Phromloungsri[e]

[a]*Department of Electronic Engineering, Faculty of Technical Education,Rajamangala University of Technology Thanyaburi, Prathumthani 12110,Thailand.*
[b]*Department of Electronic Technology, Faculty of Science, Ramkhamhaeng University Bangkok 10240, Thailand*
[c]*Nano Photonics Research Group, Department of Electrical Engineering Faculty of Industry and Technology, Rajamangala University of Technology Isan Sakon Nakhon Campus, Sakon Nakhon, 47160, Thailand*
[d]*Nanoscale Science and Engineering Research Alliance(N'SERA), Faculty of Science King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand*
[e]*Department of Electronics Engineering, Faculty of Technology, Udonthani Rajabhat University,Udonthani, 41000, Thailand*

Elsevier use only: Received 30 September 2011; Revised 10 November 2011; Accepted 25 November 2011.

Abstract

We propose a novel system that can be used to generate the new optical communication that have shown the optimize results with various RFID applications. Gaussian pulse with center wavelengths from 1,300 nm are used, which this system is very simple for used. Whereas the suitable simulation parameters are input power, pulse width, ring radii are 5-12µm and the material refractive indices (κ) are 0.10-0.97. The potential applications carrier generation for a new THz RFID is 0.2 THz by micro-nano ring resonator device.

Keywords: Nonlinear optical device; nonlinear waveguide; ring resonator; THz communication; optical radio

1. Introduction

Nanoelectronics has become the interesting research subject, in which both theoretical and experiment work have report the significant results the nano-electronic devices with reactively fabricated semiconductor show report the electronic nano devices fabrication method based on the Hall effect including the connection through a thermally activated reaction, interconnects for novel state variables:

* Corresponding author. *E-mail address*: s_buncha@yahoo.com.

1877-7058 © 2012 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.proeng.2012.01.1300

performance modelling and device and circuit implications, highly sensitive detector for on-chip near-field THz imaging and atomistic modelling of realistically extended semiconductor devices with NEMO and OMEN with represent realistically large devices on an atomistic basis has been the key element in matching experimental data and guiding experiments [1-4]. This re-entry about optoelectronic result hybrid silicon photonics for optical interconnects, low-loss chip-to-chip optical interconnection using multi-chip optoelectronic package with 40-Gb/s optical I/O for computer applications, an 8.5-Gb/s fully integrated CMOS optoelectronic receiver using slope-detection adaptive equalizer with show an OEIC with on-chip photodiode is presented. Bandwidth and responsivity are compensated by a compact adaptive equalizer, thus achieving 8.5Gb/s operation and frequency-dependent complex conductivities and dielectric responses of indium Tin Oxide thin films from the visible to the far-infrared [5-8].

Radio frequency identification (RFID) has been recognized as the challenging device for various application to distributed target tracking using signal strength measurements by a wireless sensor network, a single-chip CMOS UHF RFID reader transceiver for Chinese mobile applications, wafer-level Parylene packaging with integrated RF electronics for wireless retinal prostheses and hybrid RFID employing optical wireless communication [9-13]. Furthermore, the Gaussian pulse generator is a simple, easily and compact design, making it more commercially viable.

In this paper, we present the theoretical background in the physical model concept, where design can be use to the novel nano radio system design for RFID application. In application, the high capacity channel, this is available for high security and high capacity via optical RFID application and wireless radio link system.

2. THz Frequency Band Generation

Light from a monochromatic light source is launched into a ring resonator with constant light field amplitude (E_0) and the router quantum key distribution as shown in Fig. 1, which is the combination of terms in attenuation (α) and phase(f_0) constants, which results in temporal coherence degradation. Hence, the time dependent input light field (E_{in}), without pumping term, can be expressed as [14]

$$E_{in}(t) = E_0 e^{-\alpha L + j\phi_0(t)}. \tag{1}$$

Here L is a propagation distance (waveguide length).

We assume that the nonlinearity of the optical ring resonator is of the Kerr-type, i.e., the refractive index is given by

$$n = n_0 + n_2 I = n_0 + (\frac{n_2}{A_{eff}})P, \tag{2}$$

where n_0 and n_2 are the linear and nonlinear refractive indexes, respectively. I and P are the optical intensity and optical power, respectively. The effective mode core area of the device is given by A_{eff} . For the microring and nanoring resonators, the effective mode core areas range from 0.10 to 0.50 μm^2.

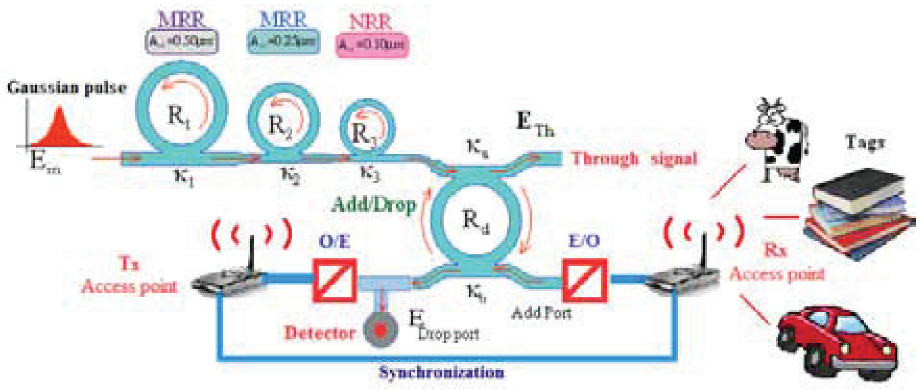

Fig. 1. Schematic of Optical THz frequency carrier system, where Rs: Ring radii, Ks : Coupling coefficients, Ka and Kb are add/drop multiplexing coupling coefficients, the system dimension is 100 x 50 μm^2

In Fig. 1 show optical RFID system to access point broadband antenna-integrated edge-coupled photo mixers for tunable terahertz sources [14] and antenna-integrated photodiodes with strained absorbers designed for use as terahertz sources [15] and the transmitter / receiver access point have synchronization system. The signal send throughout by the antenna Tx and the receiver when receive the signal coming into the system again.

When a Gaussian pulse is input and propagated within a fiber ring resonator, the resonant output is formed, thus, the normalized output of the light field is the ratio between the output and input fields ($E_{out}(t)$ and $E_{in}(t)$) in each roundtrip, which can be expressed as [16-17].

$$\left|\frac{E_{out}(t)}{E_{in}(t)}\right|^2 = (1-\gamma)\left[1-\frac{(1-(1-\gamma)x^2)\kappa}{(1-x\sqrt{1-\gamma}\sqrt{1-\kappa})^2+4x\sqrt{1-\gamma}\sqrt{1-\kappa}\sin^2(\frac{\phi}{2})}\right] \tag{3}$$

Equation (3) indicates that a ring resonator in the particular case is very similar to a Fabry-Perot cavity, which has an input and output mirror with a field reflectivity, (1-κ), and a fully reflecting mirror. k is the coupling coefficient, and

$\phi_x = \exp(-\alpha L/2)$ represents a roundtrip loss coefficient, $\phi_0 = kLn_0$ and $\phi_{NL} = kL(\frac{n_2}{A_{eff}})P$ are the linear and nonlinear phase shifts, $k = 2\pi/\lambda$ is the wave propagation number in a vacuum. Where L and α are a waveguide length and linear absorption coefficient, respectively. In this work, the iterative method is introduced to obtain the results as shown in equation (4), similarly, when the output field is connected and input into the other ring resonators.

The input optical field as shown in equation (1), i.e. a Gaussian pulse, is input into a nonlinear microring resonator. By using the appropriate parameters, the chaotic signal is obtained by using equation (2). To retrieve the signals from the chaotic noise, we propose to use the add/drop device with the appropriate parameters. This is given in details as followings. The optical outputs of a ring resonator add/drop filter can be given by the equations (4) and (5).

$$\left|\frac{E_t}{E_{in}}\right|^2 = \frac{(1-\kappa_1)-2\sqrt{1-\kappa_1}\cdot\sqrt{1-\kappa_2}\,e^{-\frac{\alpha}{2}L}\cos(k_nL)+(1-\kappa_2)e^{-\alpha L}}{1+(1-\kappa_1)(1-\kappa_2)e^{-\alpha L}-2\sqrt{1-\kappa_1}\cdot\sqrt{1-\kappa_2}\,e^{-\frac{\alpha}{2}L}\cos(k_nL)} \tag{4}$$

and

$$\left|\frac{E_d}{E_{in}}\right|^2 = \frac{\kappa_1\kappa_2 e^{-\frac{\alpha}{2}L}}{1+(1-\kappa_1)(1-\kappa_2)e^{-\alpha L} - 2\sqrt{1-\kappa_1}\cdot\sqrt{1-\kappa_2}\,e^{-\frac{\alpha}{2}L}\cos(k_n L)} \qquad (5)$$

Here E_t and E_d represents the optical fields of the throughput and drop ports respectively. The transmitted output can be controlled and obtained by choosing the suitable coupling ratio of the ring resonator, which is well derived and described by reference [15].

Here $\beta = kn_{eff}$ represents the propagation constant, n_{eff} is the effective refractive index of the waveguide, and the circumference of the ring is $L = 2\pi R$, here R is the radius of the ring. In the following, new parameters will be used for simplification, where $\phi = \beta L$ is the phase constant. The chaotic noise cancellation can be managed by using the specific parameters of the add/drop device, which the required signals at the specific wavelength band can be filtered and retrieved. $K_1$and K_2 are coupling coefficient of add/drop filters, $k_n = 2\pi/\lambda$ is the wave propagation number for in a vacuum, and the waveguide (ring resonator) loss is α = 0.5 dBmm^{-1}. The fractional coupler intensity loss is γ = 0.1. In the case of add/drop device is linear device.

3. Radio Frequency Band Generation

In Fig. 2 show the result of the rings and add/drop device which input signal is Gaussian pulse 2 W in Fig. 2(a). The output of first ring (R_1) is chaotic signal and cancellation chaotic signal by the second (R_2) and the third ring (R_3). The parameters of ring radii are 15µm, 9 µm and 9 µm for R_1-R_3 show Fig. 2(b-d) and the couple coefficient of the rings are 0.88, 0.92 and 0.93. The center wavelength is 1.3 µm in Fig. 2 (e) and Fig. 2(g) show the output signal of drop port and through put port by ring radii of add/drop is 50µm.The Fig. 2(f) and Fig. 2(h) show the exchange spatial mode to frequency domain of through put port and drop port at the frequency between 230.8-231.2 THz and bandwidth (BW) is 0.40 THz. The parameter of add/drop device couple coefficient are 0.1 (κ_{d1} and κ_{d2}).

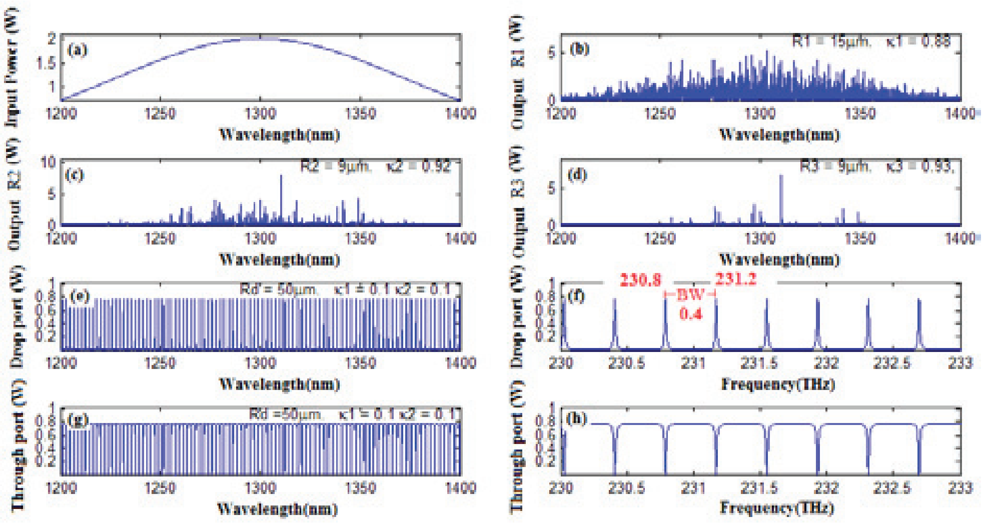

Fig. 2. Shows the output signal of DWDM to optical THz is high frequency carrier system

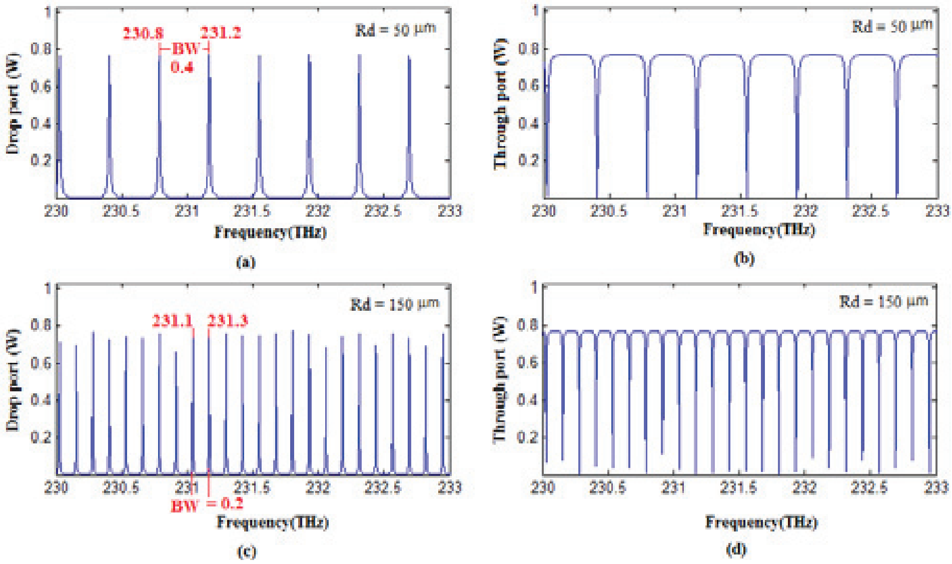

Fig. 3. shows the band width THz frequency expansion

In Fig. 3 (a-b) show the expansion of Fig. 3(e) and Fig. 3(g) have bandwidth is 0.4 THz. The bandwidth can be variable by change the ring radius of add/drop parameter occurred show in Fig. 3(c) and Fig. 3(d) is 150 µm and the system can be design the channel more than 300 channels.

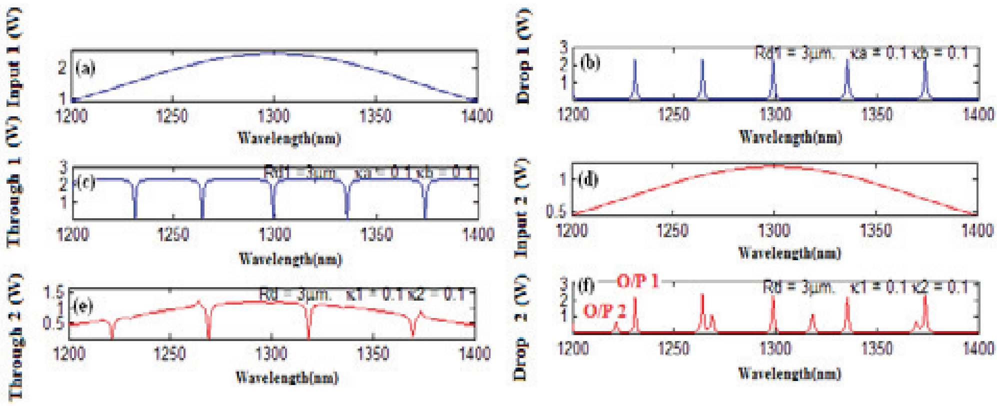

Fig. 4. shows the modulation of RFID by THz communication from schematic of optical THz frequency Fig. 1

In this Fig. 4 show the carrier signal of RFID system for application multi channel from Fig. 1, which input signal Gaussian pulse is 2.5 W in Fig. 4(a).When the chaotic signal into the add/drop filter show drop port 1 and throughput port 1 in Fig. 4(b)-(c), which we can use for transmission access point (Tx) after convert optical signal to electrical signal by O/E converter. When the add port have signal from receiver access point (Rx) to convert signal by E/O converter show input is 1.5 W in Fig. 4(d) and show the drop port 2 in Fig. 4(f), which have two signal show O/P1signal is higher more than the O/P2 signal because occurred multiplexing of the Input 1 (Fig.4-a) and Input 2 (Fig. 4-d) , In the Fig. 4(e) show the signal through put port 2 into the optical communication network.

5. Conclusion

We present a new technique carrier generation THz frequency for RFID in optical waveguide and very simple connection and technique on continues variable high frequency (THz) for multi-channel. An add/drop filters that are in the parts can be used to form transmitter (T_X) and receiver (R_X) states in the link and wireless communication for THz frequency, respectively. Results obtained have shown that the multiplexed signals can be performed by using the wavelength router and change to frequency domain in the single and similar system, which is allowed to retrieve the security RFID application multi-channel by the end users and can be application a simultaneous short wave and millimeter wave generation using a soliton pulse within a nano-waveguide [18] and we can fabricate the waveguide-coupled AlGaAs/GaAs microcavity ring [19-20].

Acknowledgement

This project is supported and granted by the Thailand Research Fund (TRF). The authors are within the Nano Photonic Research Group (NPRG), Rajamangala University of Technology Isan, Sakhon-Nakon Campus and Advance Research Center for Photonics (ARCP), Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand.

References

[1] Kim, Jooho, Akinaga Hiro, Atoda Nobufumi, Tominaga Junji, "Nanoelectronic devices with reactively fabricated semiconductor", *Applied Physics Letters*,2002,**80**: 2764 – 2766.

[2] Rakheja S., Naeemi A., "Interconnects for Novel State Variables: Performance Modeling and Device and Circuit Implications", *Electron Devices of IEEE Transactions*, 2010, **57** : 2711 – 2718.

[3] Kawano Y., "Highly Sensitive Detector for On-Chip Near-Field THz Imaging", *Selected Topics in Quantum Electronics of IEEE Journal* , 2011,**17**:67 – 78.

[4] Klimeck G., Luisier M., "Atomistic Modeling of Realistically Extended Semiconductor Devices with NEMO and OMEN" ,*Computing in Science & Engineering* , 2010,**12**: 28 – 35.

[5] Heck M.J. R., Hui-Wen Chen, Fang A.W., Koch B.R., Di Liang, Hyundai Park, Sysak M.N., Bowers J.E., "Hybrid Silicon Photonics for Optical Interconnects", *Selected Topics in Quantum Electronics of IEEE Journal*, 2011,**17**:333 – 346.

[6] Takagi Y., Suzuki A., Horio T., Ohno T., Kojima T., Takada T., Iio S., Obayashi K., Okuyama M., "Low-Loss Chip-to-Chip Optical Interconnection Using Multichip Optoelectronic Package With 40-Gb/s Optical I/O for Computer Applications", *Lightwave Technology Journal,* 2010,**28**: 2956 – 2963.

[7] Dongmyung Lee, Jungwon Han, Gunhee Han, Sung Min Park, "An 8.5-Gb/s Fully Integrated CMOS Optoelectronic Receiver Using Slope-Detection Adaptive Equalizer" ,*Solid-State Circuits of IEEE Journal*, 2010,**45**: 2861 – 2873.

[8] Ching-Wei Chen, Yen-Cheng Lin, Chia-Hua Chang, Peichen Yu, Jia-Min Shieh, Ci-Ling Pan, "Frequency-Dependent Complex Conductivities and Dielectric Responses of Indium Tin Oxide Thin Films From the Visible to the Far-Infrared" ,*Quantum Electronics of IEEE Journal*, 2010,**46**,:1746 – 1754.

[9] Oka A., Lampe L., "Distributed target tracking using signal strength measurements by a wireless sensor network" ,*Selected Areas in Communications of IEEE Journal* , **28** ,2010:1006 – 1015.

[10] Le Ye, Huailin Liao, Fei Song, Jiang Chen, Chen Li, Jinshu Zhao, Ruiqiang Liu, Chuan Wang, Congyin Shi, Junhua Liu, Ru Huang, Yangyuan Wang, "A Single-Chip CMOS UHF RFID Reader Transceiver for Chinese Mobile Applications", *Solid-State Circuits of IEEE Journal*,2010, **45** :1316 – 1329.

[11] Wen Li, Rodger D.C., Meng E., Weiland J.D., Humayun M.S., Yu-Chong Tai, "Wafer-Level Parylene Packaging With Integrated RF Electronics for Wireless Retinal Prostheses" , *Micro electromechanical Systems Journal*, 2010,**19**:735 – 742.

[12] Jun Yin, Jun Yi, Law M.K., Yunxiao Ling, Man Chiu Lee, Kwok Ping Ng, Bo Gao, Luong H.C., Bermak A., Mansun Chan, Wing-Hung Ki, Chi-Ying Tsui, Yuen M., "A System-on-Chip EPC Gen-2 Passive UHF RFID Tag With Embedded Temperature Sensor" ,*Solid-State Circuits of IEEE Journal*, 2010,**45**: 2404 – 2420.

[13] Noonpakdee W., Jiang Liu, Kim Dong Hyun, Shimamoto S., “Hybrid RFID employing optical wireless communication”,Wireless Information Technology and Systems (ICWITS), *2010 IEEE International Conference on*, 2010,**1** : 1 – 4.

[14] Henning I.D., Adams M.J., Yun Sun, Moodie D.G., Rogers D.C., Cannard P.J., Dosanjh S., Skuse M., Firth R.J., “Broadband Antenna-Integrated, Edge-Coupled Photo mixers for Tunable Terahertz Sources”, *Quantum Electronics,IEEE Journal* ,2010,**46** :1498 – 1505.

[15] Henning I.D., Adams M.J., Vaughan M., Abraham T., Yun Sun, Dyson A., Moodie D.G., Rogers D.C., Cannard P.J., Dosanjh S., Skuse M., Firth R.J., “Novel Antenna-Integrated Photodiodes With Strained Absorbers Designed for Use as Terahertz Sources”, *Selected Topics in Quantum Electronics, IEEE Journal*, 2011*,* **17**: 202 – 209.

[16] P.P. Yupapin and W. Suwancharoen, “Chaotic signal generation and cancellation using a microring resonator incorporating an optical add/drop multiplexer,” *Opt. Commun.,* 2007, **280** : 343-350.

[17] P.P. Yupapin, P. Saeung and C. Li, “Characteristics of complementary ring-resonator add/drop filters modeling by using graphical approach”, *Opt. Commun.,* 2007, **272**: 81-86.

[18] S. Mithata, N. Pornsuwancharoen and P.P. Yupapin, “A simultaneous short wave and millimeter wave generation using a soliton pulse within a nano-waveguide”, *IEEE Photon. Technol. Lett.,* ,2009,**21**: 932-934.

[19] D. Wake, S. Dupont, C. Lethien, J-P. Vilcot, and D. Decoster, “Radiofrequency Transmission over Multimode Fibre for Distributed Antenna System Applications”, *Electronic Letters* 2001, **37:**1087 – 1089.

[20] D. Rafizadeh, J. P. Zhang, S. C. Hagness, A. Taflove, K. A. Stair, and S. T. Ho, “Waveguide-coupled AlGaAs/GaAs microcavity ring and disk resonators with high finesse and 21.6-nm free spectral range,” *Opt. Lett.*, 1997,**22**:1244–1246.